

How was Felt Van Earthquake by a Neighbor University Hospital?

Yilmaz ZENGİN,¹ Mustafa ICER,¹ Ercan GUNDUZ,¹ Recep DURSUN,¹ Hasan Mansur DURGUN,¹
Mehmet Nezir GULLU,² Murat ORAK,¹ Cahfer GULOGLU¹

¹Department of Emergency Medicine, Dicle University, Diyarbakır;

²Department of Internal Medicine, Hacettepe University, Ankara, both in Turkey

SUMMARY

Objectives

Natural disasters, which are defined as events causing great damage or loss of life, are events of natural origin unpreventable by human beings that occur in a short period of time and lead to loss of life and property. The aim of the study is to analyze which patient groups and problems at a university hospital after the earthquakes in Van.

Methods

For the purposes of this study, 169 patients who presented to our emergency room following the earthquakes that occurred on the 23rd of October, 2011 and the 9th of November, 2011 in Van and were treated as an outpatient or inpatient were enrolled. Patients were divided into two groups. Patient data including the clinical and demographic characteristics were analyzed.

Results

Among the 169 patients included in our study, 97 (57.4%) were male and 72 (42.6%) were female. The mean age was 26.95 ± 16.44 years in Group 1 and 39.80 ± 23.08 years in Group 2. In our study, the majority of the patients in Group 1 had orthopedic injuries, while internal problems were more common in Group 2. The need for intensive care was greater among the patients in Group 1 compared to Group 2 ($p < 0.05$). The leading cause of death in Group 1 was multi-systemic trauma in 7 out of the 10 patients (70%) and internal problems in Group 2 with 5 out of 12 patients (41.5%).

Conclusions

Our country is in a geographical location where earthquakes are responsible for great losses of life and property. An efficient disaster relief plan may help to minimize the possible damage of earthquakes.

Key words: Disaster; university hospital; Van earthquake.

Submitted: November 24, 2014 **Accepted:** December 09, 2014 **Published online:** January 20, 2015

Correspondence: Dr. Yilmaz Zengin. Dicle Universitesi, Tıp Fakültesi, Acil Tıp Anabilim Dalı,
21280 Diyarbakır, Turkey.

e-mail: yilmazzengin79@myynet.com



© 2015 Emergency Medicine Association of Turkey. Production and Hosting by Elsevier B.V. Originally published in [2015] by Kare Publishing. This is an open access article under CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Turk J Emerg Med 2015;15(1):33-38 doi: 10.5505/1304.7361.2015.03274

Introduction

Natural disasters, which are defined as events causing great damage or loss of life, are events of natural origin unpreventable by human beings that occur in a short period of time and lead to loss of life and property.^[1] Earthquakes are among the leading natural disasters that cause the greatest number of mortalities and disabilities both in our country and around the world.^[2,3] The earthquakes that occurred in Van on the 23rd of October, 2011 and the 9th of November, 2011 measuring 7.2 and 5.6 on the Richter scale, respectively, caused a total of 644 fatalities and destroyed or severely damaged nearly 30,000 buildings in Van, Erzurum and the surrounding provinces and townships.^[4] Although earthquakes occur frequently in our country due to its location in an earthquake-prone zone, unplanned urbanization and structurally weak buildings as well as inadequate earthquake education and preparation still contribute to high rates of earthquake-related fatalities and disabilities.^[5,6] Therefore, earthquake-associated data should be gathered, meticulously analyzed and published in order for the necessary measures against future earthquakes to be taken.

This study presents a retrospective analysis of the patients who presented to our emergency department after the earthquakes in Van. The aim of the study is to analyze which patient groups and problems can be expected at a university hospital after a natural disaster such as an earthquake.

Material and Method

For the purposes of this study, 169 patients who presented to our emergency department following the earthquakes that occurred on the previously mentioned dates in Van and were treated in an outpatient or inpatient status were enrolled. The type of study was a retrospective cross-sectional study. Patients were divided into two groups as patients who presented after the first earthquake on the 23rd of October, 2011 (Group 1, n=41) and those who presented after the second large earthquake on the 9th of November, 2011 (Group 2, n=128). Patient data including age, gender, reason for referral, diagnoses, subsequent clinical condition, need for blood transfusion, compartment syndrome, amputations, crush syndrome, surgeries, need for dialysis, need for intensive care, laboratory results, length of hospital stay, and the outcome were retrieved from the hospital data base and analyzed. Patients whose data in the file could not be verified or was inadequate were excluded from the study. Differences between Group 1 and Group 2 in terms of the assessed parameters were investigated. This study was approved by the local ethical committee (2013/180).

The statistical analysis was performed using the SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) software. The normality of

the data was tested using the Kolmogorov-Smirnov test. The results were expressed as mean \pm SD or number of patients. Categorical data were analyzed using the chi-square test. For the normally distributed continuous variables, the student's t test was used for statistical comparisons. Statistical significance was based on a p-value of <0.05.

Results

Among the 169 patients included in our study, 97 (57.4%) were male and 72 (42.6%) were female. The mean age was 26.95 \pm 16.44 years in Group 1 and 39.80 \pm 23.08 years in Group 2. The clinical and demographic characteristics of the patients are presented in Table 1. Among the 131 patients admitted to the hospital, 42 (32.1%) were in internal medicine, 18 (13.7%) were in orthopedics and traumatology, 16 (7.7%) were in the pediatrics and pediatric surgery departments, 11 (5.3%) were in neurosurgery, and 44 (33.5%) were in the other services. The length of the hospital stay was 10.85 \pm 9.85 days in Group 1 and 8.68 \pm 12.71 days in Group 2. Three out of the 5 patients (60%) who underwent fasciotomies had to receive hemodialysis due to acute renal failure. The mean age of the mortalities in Group 1 was 24 \pm 16.9, while the mean age among the mortalities in Group 2 was 26.6 \pm 29.7 years. The leading cause of death in Group 1 was multi-systemic trauma in 7 out of the 10 patients (70%) and internal problems in Group 2 with 5 out of 12 patients (41.5%).

Discussion

Within the last 25 years, natural disasters have caused over 3 million deaths and disabilities and affected the living standards of approximately 800 million people around the world.^[7] Earthquakes are the most destructive kind of natural disasters in terms of loss of life and property.^[8] Due to our country's high-risk location in an earthquake-prone zone, 100,000 people have lost their lives between the years 1908 and 1995. Furthermore, the Marmara earthquake on the 17th of August, 1999 caused 17,127 mortalities and 604 people were lost in the earthquake in Van in 2011.^[6,9,10] The great number of structurally weak buildings and the inadequate disaster response and recovery framework lead to higher mortality rates after these earthquakes. The relatively lower number of fatalities in the earthquake in Van was due to the advantageous timing of the earthquake during daytime at a weekend when only few people were inside buildings.

In a study where the patients who had presented to the Uludağ University hospital after the Marmara earthquake, 147 out of 330 of the wounded patients were admitted to the Orthopedics and Traumatology clinic, while the other patients were followed up by the general surgery, plastic surgery, and cardiothoracic surgery departments.^[11] In an-

Table 1. The clinical and demographic characteristics of the patients

	Group 1	Group 2	P*
	n (%)	n (%)	
Gender			
Female	15 (36.6)	57 (44.5)	
Male	26 (63.4)	71 (55.5)	0.46
Extremity injury			
Upper	3 (7.3)	0 (0)	0.01
Lower	8 (19.5)	3 (2.3)	0.01
Pelvis	4 (9.8)	0 (0)	0.03
Vertebra	3 (7.3)	0 (0)	0.01
Lung injury			
Hemothorax	3 (7.3)	1 (0.8)	0.04
Pneumothorax	2 (4.9)	0 (0)	0.06
Rib fractures	4 (9.8)	1 (0.8)	0.01
Head injury			
Subarachnoid hemorrhage	1 (2.4)	2 (1.6)	0.56
Epidural hemorrhage	1 (2.4)	1 (0.8)	0.42
Parenchymal hemorrhage	1 (2.4)	1 (0.8)	0.42
Pregnancy	1 (2.4)	6 (4.7)	1
Ocular injury	1 (2.4)	3 (2.3)	1
Abdominal injury	1 (2.4)	12 (9.4)	0.19
Liver injury	2 (4.9)	0 (0)	0.06
Splenic injury	2 (4.9)	0 (0)	0.06
Pneumonia	1 (2.4)	8 (6.3)	0.69
Acute coronary syndrome	0 (0)	5 (3.9)	0.33
Diabetes mellitus	0 (0)	3 (2.3)	1
Blood transfusion	14 (34.1)	7 (5.5)	<0.001
Compartment syndrome	5 (12.2)	0 (0)	<0.001
Amputation	1 (2.4)	0 (0)	0.24
Crush syndrome	16 (39.6)	0 (0)	<0.001
Performed operations	20 (48.8)	16 (12.5)	<0.001
Chronic renal failure	0 (0)	58 (45.3)	<0.001
Dialysis	8 (19.5)	57 (44.5)	0.01
Need for intensive care	15 (36.6)	22 (17.2)	0.01
Death	10 (24.4)	12 (9.4)	0.03

* Chi-squared test.

other study on the Marmara earthquake, the majority of the patients who had presented to hospitals were reported to be admitted to the Orthopedics and Traumatology clinic and 96 out of the 160 operations were orthopedic surgeries.^[12] In India, the majority of the injuries after the earthquake in Gujarat were orthopedic conditions.^[13] Also in the study by Dursun et al, the majority of patients who presented after the Van earthquake were reported to be orthopedic pa-

tients with 28%.^[14] In our study, the majority of the patients in Group 1 had orthopedic injuries, while internal problems were more common in Group 2. We are of the opinion that this was caused by the fact that a greater number of the locals had abandoned the damaged buildings after the first earthquake and moved into tents.

One of the most important problems observed after earthquakes is crush syndrome or traumatic rhabdomyolysis that

occurs due to the exposure of the muscle tissue to pressure over longer periods.^[15] Crush injuries were reported in 600 patients after the earthquake in Armenia in 1988, 372 patients after the Hanshin-Awaji earthquake in 1995, 110 patients who presented to the Uludag University hospital after the Marmara earthquake in 1999, 202 patients after the Wenchuan earthquake in China in 2008 and in 46 patients after the earthquake in Van.^[11,16-20] In our study, 16 (39.6%) of the patients in Group 1 had crush injuries, while no crush injuries were observed in any of the patients in Group 2. This result may be associated with the fact that the majority of locals had left their houses after the first earthquake, as well as the relatively lower magnitude of the second earthquake.

Following crush injuries, the increased pressure on the skeletal muscles in the extremities and the reduction in the capillary perfusion leads to compartment syndrome that is characterized by ischemia, dysfunction and tissue necrosis.^[21,22] Although compartment syndrome frequently occurs in the forearms and legs, it may also be observed in the hands, feet, arms, shoulders and thighs.^[9] Starting an effective treatment at an early stage may reduce the mortality and morbidity associated with compartment syndrome.^[23] During the early stage (the first 6-12 hours) a fasciotomy with the surgically appropriate and accurate indication and wound debridement should be performed and antibiotic therapy should be initiated.^[20] In the literature, amputation rates after fasciotomies performed due to crush injury are given as 4- 21%.^[23,24] After the Marmara earthquake, 92 out of the 146 patients with crush injuries admitted to the Gulhane Haydarpaşa Training Military Hospital underwent fasciotomies and 5 patients (5.4%) had subsequent amputations. After the Wenchuan earthquake, 15 out of 32 patients were given fasciotomies and 5 (15.6%) out of these had to undergo amputations. After the earthquake that occurred in Van in 2011, 21 out of the 46 patients admitted to the Van Regional Training and Research Hospital with crush injuries had received fasciotomies and 7 (15%) out of these later required amputations.^[20,25,26] In our study, 1 patient (20%) out of the 5 patients who had undergone fasciotomies due to compartment syndrome in Group 1 had to receive an amputation. The higher rate of amputation in our study may result from the low number of patients in our study.

Another problem faced due to crush injuries is the need for hemodialysis.^[9] According to a study conducted on the 1988 Armenian earthquake, 80 (67%) out of the 120 patients with crush injuries required hemodialysis; while 156 patients had to receive hemodialysis after the Iranian earthquake in 1990; 491 out of the 704 patients with crush injuries underwent dialysis after the Marmara earthquake in 1999, and 9 out of 21 patients with crush injuries were treated through hemodialysis after the 2011 Van earthquake.^[20,27-29] In our study, 8 out of the 16 patients with crush injuries and serum creati-

nine concentrations over 5 mg/dl in Group 1 received hemodialysis due to acute renal failure.

Management of the chronic renal failure patients undergoing dialysis is one of the greatest problems following earthquakes. After the Marmara earthquake, 266 of the 531 dialysis patients in the region had to receive treatment in the neighboring provinces.^[29] In our study, 57 of the chronic dialysis patients in Group 2 were observed to present to our hospital since the dialysis centers at which they normally received treatment were destroyed or severely damaged.

Another problem faced after earthquakes is the need for intensive care.^[30] According to a study conducted on the Marmara earthquake, 10 (10.5%) out of the 95 patients who presented to the hospital required intensive care, while 39 (13%) out of the 301 hospitalized patients after the earthquake in Van had to be admitted to intensive care.^[14,30] In our study, the need for intensive care was greater among the patients in Group 1 compared to Group 2. This may be explained by the greater magnitude of the first earthquake and the higher number of the severe injuries.

When the earthquake mortalities were evaluated based on age groups, approximately half of the deaths are observed to occur between the ages of 20 and 40.^[14] A previous study reported an earthquake mortality risk in the age group above 65 years to be 2.9 times higher.^[31] Accordingly, the majority of the fatalities after the Sultandagi earthquake were observed in the age group <65 years.^[32] In the study by Dursun et al. on the earthquake in Van, the majority of the fatalities were found to be between 20-40 years of age.^[7] Also in our study, the majority of the deaths were among the younger generation in both groups. This result may be associated with the younger population of the city and the concentration of the damage on the buildings at the city center.

Although the causes of mortality vary after earthquakes, deaths at the site mainly occur due to respiratory failure due to entrapment under debris, while hospital deaths are usually associated with multi-systemic trauma.^[33] A previous study pointed out the three top causes of death in the Hanshin-Awaji earthquake as abdominal trauma, head trauma and thoracic trauma.^[34] Also in the Marmara earthquake of 1999, the causes of death among the patients followed up at different hospitals comprised multi-systemic traumas including abdominal, head and chest trauma.^[11,12] In our study, the high prevalence of multi-systemic traumas as the leading cause of death in Group 1 in comparison to Group 2 may be explained with the reduced risk of trauma in the second earthquake after the locals had left their buildings to stay in tents. On the other hand, the prevalence of internal problems in Group 2 may be explained by the high number of the healthcare centers rendered dysfunctional after the two earthquakes.

Conclusion

Our country is in a geographical location where earthquakes are responsible for great loss of life and property. For this reason, all the data about earthquakes from our country should be gathered, the necessary measures taken, adequate education given, disaster relief plans prepared and regular drills should be performed. An efficient disaster relief plan may help to minimize the possible damage of earthquakes.

Conflict of Interest

The authors declare that there is no potential conflicts of interest.

References

- Gulkan P, Sucuoglu H. Course on disaster preparedness and management. Dogal Afetlerin Tipleri ve Etkileri: T.C. Bayındırlık ve İskan Bakanlığı, Ankara: s. 9-25.
- Taviloglu K. Felaketlerde yaralılara yaklaşımlar ve hekimlik hizmetleri. In: Depremlerde uzmanlık hizmetleri. İstanbul Tabip Odası Yayınları, İstanbul: Ekspres Ofset; 2000. s. 1-36.
- Cakmakci M. Felakette sağlık düzeni. Bilim Teknik Dergisi 1999;31:11-7.
- Yagmurlu F, Senturk M, Dumlupinar İ. 23 Ekim 2011 ve 9 Kasım 2011 tarihlerinde meydana gelen Van depremlerinin jeolojik değerlendirmesi. SDU Geo 2011;2:3-10.
- Schultz CH, Koenig KL, Noji EK. A medical disaster response to reduce immediate mortality after an earthquake. N Engl J Med 1996;334:438-44. [CrossRef](#)
- Taviloğlu K. 17 Ağustos 1999 Marmara depreminin ardından: Felaket organizasyonunda neredeyiz? Ulusal Cerrahi Derg 1999;15:333-42.
- Peek-Asa C, Kraus JF, Bourque LB, Vimalachandra D, Yu J, Abrams J. Fatal and hospitalized injuries resulting from the 1994 Northridge earthquake. Int J Epidemiol 1998;27:459-65.
- Building Seismic Safety Council. Seismic considerations: Health care facilities. Washington DC: Federal Emergency Management Agency Publication, FEMA 150;1990.
- Yıldız Ş, Yıldız DŞ, Özkan DS, Dündar DK, Ay DH, Kırıl DZM, et al. Hyperbaric Oxygen Therapy In Crush Injuries After 17th Of August Earthquake In Marmara. Gulhane Med J 2004;46:194-9.
- Atasoy S, Ziyalar N, Alsancak B. Earthquake epidemiology in Turkey: 1900-1995. (Poster) American Academy of Forensic Sciences 51. Annual Meeting. Orlando, Florida, USA 1999:15-20.
- Bulut M, Turanoğlu G, Armağan E, Akköse S, Özgüç H, Tokyay R. The analysis of traumatized patients who were admitted to the Uludag University Medical School Hospital after the Marmara earthquake. [Article in Turkish] Ulus Travma Derg 2001;7:262-6.
- Kurt N, Küçük HF, Celik G, Demirhan R, Gül O, Altaca G. Evaluation of patients wounded in the 17 August 1999 Marmara earthquake. [Article in Turkish] Ulus Travma Derg 2001;7:49-51.
- Phalkey R, Reinhardt JD, Marx M. Injury epidemiology after the 2001 Gujarat earthquake in India: a retrospective analysis of injuries treated at a rural hospital in the Kutch district immediately after the disaster. Glob Health Action 2011;4:7196.
- Dursun R, Görmeli CA, Görmeli G. Evaluation of the patients in Van Training and Research Hospital following the 2011 Van earthquake in Turkey. [Article in Turkish] Ulus Travma Acil Cerrahi Derg 2012;18:260-4. [CrossRef](#)
- Better OS, Abassi Z, Rubinstein I, Marom S, Winaver Y, Silberman M. The mechanism of muscle injury in the crush syndrome: ischemic versus pressure-stretch myopathy. Miner Electrolyte Metab 1990;16:181-4.
- Oda J, Tanaka H, Yoshioka T, Iwai A, Yamamura H, Ishikawa K, et al. Analysis of 372 patients with Crush syndrome caused by the Hanshin-Awaji earthquake. J Trauma 1997;42:470-6. [CrossRef](#)
- Shimazu T, Yoshioka T, Nakata Y, Ishikawa K, Mizushima Y, Morimoto F, et al. Fluid resuscitation and systemic complications in crush syndrome: 14 Hanshin-Awaji earthquake patients. J Trauma 1997;42:641-6. [CrossRef](#)
- Oda Y, Shindoh M, Yukioka H, Nishi S, Fujimori M, Asada A. Crush syndrome sustained in the 1995 Kobe, Japan, earthquake; treatment and outcome. Ann Emerg Med 1997;30:507-12. [CrossRef](#)
- Quan Y, Pan X, Deng S, Lu S, Tao S, Zhou J, et al. Features of crush injury in Wenchuan earthquake and the corresponding operational methods. [Article in Chinese] Zhongguo Xue Fu Chong Jian Wai Ke Za Zhi 2009;23:549-51. [Abstract]
- Görmeli G, Görmeli CA, Güner S, Ceylan MF, Dursun R. A clinical analysis of patients undergoing fasciotomy who experienced the 2011 Van earthquake. [Article in Turkish] Ekleml Hastalıkları Cerrahisi 2012;23:156-60.
- Coget JM. The compartment syndrome. [Article in French] Phlebologie 1989;42:259-69.
- von Schroeder HP, Botte MJ. Crush syndrome of the upper extremity. Hand Clin 1998;14:451-6.
- Rollins DL, Bernhard VM, Towne JB. Fasciotomy: an appraisal of controversial issues. Arch Surg. 1981;116:1474-81. [CrossRef](#)
- Duman H, Kulahci Y, Sengezer M. Fasciotomy in crush injury resulting from prolonged pressure in an earthquake in Turkey. Emerg Med J 2003;20:251-2. [CrossRef](#)
- Us HM, Rodop O, Özkan S, Civelek A, Elbüken E, İnan K. Our Experiences In Treatment Of Compartment Syndrome After 17 August Earthquake. [Article in Turkish] Turkish J Thorac and Cardiovasc Surg 2000;8:805-7.
- Li W, Qian J, Liu X, Zhang Q, Wang L, Chen D, et al. Management of severe crush injury in a front-line tent ICU after 2008 Wenchuan earthquake in China: an experience with 32 cases. Crit Care 2009;13:R178. [CrossRef](#)
- Richards NT, Tattersall J, McCann M, Samson A, Mathias T, Johnson A. Dialysis for acute renal failure due to crush injuries after the Armenian earthquake. BMJ 1989;298:443-5. [CrossRef](#)
- Nadjafi I, Atef MR, Broumand B, Rastegar A. Suggested guidelines for treatment of acute renal failure in earthquake victims. Ren Fail 1997;19:655-64. [CrossRef](#)
- Erek E, Sever MŞ. Marmara Earthquake and Turkish Nephrology. Türk Nefroloji Diyaliz ve Transplantasyon Dergisi 1999;4:158-62.
- Akpek AE, Dönmez A, Kızılkın A, Arslan G. Role Of A Back-Up Anaesthesia Department After Massive Disaster: Our Ex-

- perience During The Marmara Earthquake. *T Klin J Med Sci* 2002;22:502-4.
31. Peek-Asa C, Ramirez M, Seligson H, Shoaf K. Seismic, structural, and individual factors associated with earthquake related injury. *Inj Prev* 2003;9:62-6. [CrossRef](#)
32. Akbulut G, Yilmaz S, Polat C, Sözen M, Leblebicioğlu M, Dilek ON. Afyon sultandagi earthquake. [Article in Turkish] *Ulus Travma Acil Cerrahi Derg* 2003;9:189-93.
33. Cakir Z, Saritas A, Aslan S, Uzkeser M, Sarıkaya S. Erzurum - Askale Earthquake and Its Results. *EAJM* 2006;38:81-4.
34. Tanaka H, Oda J, Iwai A, Kuwagata Y, Matsuoka T, Takaoka M, et al. Morbidity and mortality of hospitalized patients after the 1995 Hanshin-Awaji earthquake. *Am J Emerg Med* 1999;17:186-91. [CrossRef](#)